# R&S®QAT100
# Advanced Antenna Array
# User Manual

ROHDE & SCHWARZ

Make ideas real

This document describes the following products.

- R&S®QAT100 (1341.0004K02)
- R&S®QAT-B11 Standard Frontend (1341.0240.11)
- R&S®QAT-B21 Single Line MIMO Frontend (1341.0240.21)
- R&S®QAT-B2 Additional Line of Tx Antennas (1341.0162.02)
- R&S®QAT-B5 Analog Stepped Delay Line (1341.0179.02)
- R&S®QAT-Z50 Shielding System (1341.0156.02)
- R&S®QAT-Z51 Shielding Extension (1341.0185.02)
- R&S®QAT-Z53 Shielding Trio (1341.0191.02)

# Contents

# 1 Safety and regulatory information

The product documentation helps you use the product safely and efficiently. Follow the instructions provided here and in the following chapters.

**Intended use**

The product is intended for the development, production and verification of electronic components and devices in industrial, administrative, and laboratory environments. Use the product only for its designated purpose. Observe the operating conditions and performance limits stated in the data sheet.

**Where do I find safety information?**

Safety information is part of the product documentation. It warns you of potential dangers and gives instructions on how to prevent personal injury or damage caused by dangerous situations. Safety information is provided as follows:

● In Chapter 1.1, "Safety instructions", on page 5. The same information is provided in many languages as printed "Safety Instructions". The printed "Safety Instructions" are delivered with the product.
● Throughout the documentation, safety instructions are provided when you need to take care during setup or operation.

## 1.1 Safety instructions

Products from the Rohde & Schwarz group of companies are manufactured according to the highest technical standards. To use the products safely, follow the instructions provided here and in the product documentation. Keep the product documentation nearby and offer it to other users.

Use the product only for its intended use and within its performance limits. Intended use and limits are described in the product documentation such as the data sheet, manuals and the printed "Safety Instructions". If you are unsure about the appropriate use, contact Rohde & Schwarz customer service.

Using the product requires specialists or specially trained personnel. These users also need sound knowledge of at least one of the languages in which the user interfaces and the product documentation are available.

Reconfigure or adjust the product only as described in the product documentation or the data sheet. Any other modifications can affect safety and are not permitted.

Never open the casing of the product. Only service personnel authorized by Rohde & Schwarz are allowed to repair the product. If any part of the product is damaged or broken, stop using the product. Contact Rohde & Schwarz customer service at https://www.rohde-schwarz.com/support.

**Lifting and carrying the product**

The maximum weight of the product is provided in the data sheet. You can lift or carry the product by yourself, if you can manage the weight on your own. Alternatively, you can use lifting or transporting equipment. Follow the instructions provided by the equipment manufacturer.

**Choosing the operating site**

Only use the product indoors. The product casing is not waterproof. Water that enters can electrically connect the casing with live parts, which can lead to electric shock, serious personal injury or death if you touch the casing. If Rohde & Schwarz provides accessories designed for your product, e.g. a carrying bag, you can use the product outdoors.

Unless otherwise specified, you can operate the product up to an altitude of 2000 m above sea level. The product is suitable for pollution degree 2 environments where nonconductive contamination can occur. For more information on environmental conditions such as ambient temperature and humidity, see the data sheet.

**Setting up the product**

Always place the product on a stable, flat and level surface with the bottom of the product facing down. If the product is designed for different positions, secure the product so that it cannot fall over.

If the product has foldable feet, always fold the feet completely in or out to ensure stability. The feet can collapse if they are not folded out completely or if the product is moved without lifting it. The foldable feet are designed to carry the weight of the product, but not an extra load.

If stacking is possible, keep in mind that a stack of products can fall over and cause injury.

If you mount products in a rack, ensure that the rack has sufficient load capacity and stability. Observe the specifications of the rack manufacturer. Always install the products from the bottom shelf to the top shelf so that the rack stands securely. Secure the product so that it cannot fall off the rack.

**Connecting to power**

The product is an overvoltage category II product. Connect the product to a fixed installation used to supply energy-consuming equipment such as household appliances and similar loads. Keep in mind that electrically powered products have risks, such as electric shock, fire, personal injury or even death. Replace parts that are relevant to safety only by original parts, e.g. power cables or fuses.

Take the following measures for your safety:

- Before switching on the product, ensure that the voltage and frequency indicated on the product match the available power source. If the power adapter does not adjust automatically, set the correct value and check the rating of the fuse.
- Only use the power cable delivered with the product. It complies with country-specific safety requirements. Only insert the plug into an outlet with protective conductor terminal.

- Only use intact cables and route them carefully so that they cannot be damaged. Check the power cables regularly to ensure that they are undamaged. Also ensure that nobody can trip over loose cables.
- If you connect the product to an external power supply, use the one delivered with the product or recommended in the product documentation. The external power supply must conform to the country-specific regulations.
- Only connect the product to a power source with a fuse protection of maximum 20 A.
- Ensure that you can disconnect the product from the power source at any time. Pull the power plug to disconnect the product. The power plug must be easily accessible. If the product is integrated into a system that does not meet these requirements, provide an easily accessible circuit breaker at the system level.

**Cleaning the product**

Use a dry, lint-free cloth to clean the product. When cleaning, keep in mind that the casing is not waterproof. Do not use liquid cleaning agents.

**Meaning of safety labels**

Safety labels on the product warn against potential hazards.

| | |
|---|---|
| ⚠ | Potential hazard<br>Read the product documentation to avoid personal injury or product damage. |
| ⚡ | Electrical hazard<br>Indicates live parts. Risk of electric shock, fire, personal injury or even death. |
| ♨ | Hot surface<br>Do not touch. Risk of skin burns. Risk of fire. |
| ⏚ | Protective conductor terminal<br>Connect this terminal to a grounded external conductor or to protective ground. This connection protects you against electric shock if an electric problem occurs. |

## 1.2 Labels on the product

Labels on the casing inform about:

- Personal safety, see "Meaning of safety labels" on page 7
- Product and environment safety, see Table 1-1
- Device information is provided on a sticker attached to the radio (rear side). The sticker contains a barcode and the device ID. The device ID is a combination of the order number and the serial number.

*Table 1-1: Labels regarding product and environment safety*

| | Labeling in line with EN 50419 for disposal of electrical and electronic equipment after the product has come to the end of its service life. For more information, see "Disposing electrical and electronic equipment" on page 56. |
| --- | --- |

## 1.3 Warning messages in the documentation

A warning message points out a risk or danger that you need to be aware of. The signal word indicates the severity of the safety hazard and how likely it will occur if you do not follow the safety precautions.

**WARNING**

Potentially hazardous situation. Could result in death or serious injury if not avoided.

**CAUTION**

Potentially hazardous situation. Could result in minor or moderate injury if not avoided.

**NOTICE**

Potential risks of damage. Could result in damage to the supported product or to other property.

## 1.4 Korea certification class B

이 기기는 가정용(B급) 전자파 적합기기로서 주로 가정에서 사용하는 것을 목적으로 하며, 모든 지역에서 사용할 수 있습니다.

## 1.5 Regulatory information

Use the R&S QAT only in a shielded environment, like an anechoic chamber, a faraday cage, or in conjunction with the R&S QAT-Z50 shielding device. However, you must stop operating the R&S QAT if you receive any reports of interference.

# 2 Documentation overview

This section provides an overview of the R&S QAT user documentation.

**User manual**

Contains the description of all R&S QAT instrument functions. It also provides information on maintenance, instrument interfaces and error messages. A printed version is included in the delivery.

**Service manual**

Describes the performance test for checking the rated specifications, module replacement and repair, firmware update, troubleshooting and fault elimination, and contains mechanical drawings and spare part lists.

**Safety instructions**

Contains safety instructions, operating conditions and further important information. A printed version is included in the delivery.

**Data sheet and brochure**

The data sheet contains the technical specifications of the R&S QAT. It also lists the options and their order numbers as well as optional accessories.

The brochure provides an overview of the R&S QAT and shows their specific characteristics.

**Release notes and open source acknowledgment**

The release notes list new features, improvements and known issues of the current firmware version.

The open source acknowledgment document provides verbatim license texts of the used open source software.

# 3 Preparing for use

Here, you can find basic information about setting up the product for the first time.

## 3.1 Lifting and carrying

You can carry the R&S QAT by its handles on the side or on the top. Do not apply excessive external force to the handles.

See "Lifting and carrying the product" on page 6.

## 3.2 Unpacking and checking

1. Unpack the product carefully.

2. Retain the original packing material. Use it when transporting or shipping the product later.

3. Using the delivery notes, check the equipment for completeness.

4. Check the equipment for damage.

   If the delivery is incomplete or equipment is damaged, contact Rohde & Schwarz.

## 3.3 Choosing the operating site

Specific operating conditions ensure proper operation and avoid damage to the product and connected devices. For information on environmental conditions such as ambient temperature and humidity, see the data sheet.

See also "Choosing the operating site" on page 6.

**Electromagnetic compatibility classes**

The electromagnetic compatibility (EMC) class indicates where you can operate the product. The EMC class of the product is given in the data sheet.

● Class B equipment is suitable for use in:
  – Residential environments
  – Environments that are directly connected to a low-voltage supply network that supplies residential buildings
● Class A equipment is intended for use in industrial environments. It can cause radio disturbances in residential environments due to possible conducted and radiated disturbances. It is therefore not suitable for class B environments.

If class A equipment causes radio disturbances, take appropriate measures to eliminate them.

## 3.4 Setting up the product

See also:
- "Setting up the product" on page 6
- "Intended use" on page 5

### 3.4.1 Placing the product on a bench top

**To place the product on a bench top**

1. Place the product on a stable, flat and level surface. Ensure that the surface can support the weight of the product. For information on the weight, see the data sheet.

2. **CAUTION!** Foldable feet can collapse. See "Setting up the product" on page 6.

   Always fold the feet completely in or out. With folded-out feet, do not place anything on top or underneath the product.

3. **WARNING!** A stack of products can fall over and cause injury. Never stack more than three products on top of each other. Instead, mount them in a rack.

   Stack as follows:

   - If the products have foldable feet, fold them in completely.
   - It is best if all products have the same dimensions (width and length). If the products have different dimensions, stack according to size and place the smallest product on top.
   - Do not exceed the permissible total load placed on the product at the bottom of the stack:
     - 50 kg when stacking products of identical dimensions (left figure).
     - 25 kg when stacking smaller products on top (middle figure).
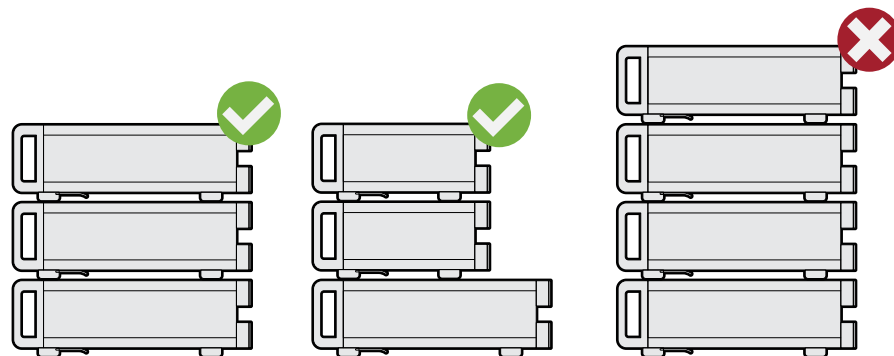
Left    = Stacked correctly, same dimensions
Middle = Stacked correctly, different dimensions
Right   = Stacked incorrectly, too many products

4. **NOTICE!** Overheating can damage the product.

   Prevent overheating as follows:

   ● Keep a minimum distance of 10 cm between the fan openings of the product
     and any object in the vicinity.
   ● Do not place the product next to heat-generating equipment such as radiators
     or other products.

### 3.4.2  Mounting the product in a rack

**To prepare the rack**

1. Observe the requirements and instructions in "Setting up the product" on page 6.

2. **NOTICE!** Insufficient airflow can cause overheating and damage the product.

   Design and implement an efficient ventilation concept for the rack.

**To mount the product in a rack**

1. Use an adapter kit to prepare the product for rack mounting.

   a) Order the rack adapter kit designed for the product. For the order number, see
      data sheet.
   b) Mount the adapter kit. Follow the assembly instructions provided with the
      adapter kit.

2. Lift the product to shelf height.

3. Grab the handles and push the product onto the shelf until the rack brackets fit
   closely to the rack.

4. Tighten all screws at the rack brackets with a tightening torque of 1.2 Nm to secure
   the product at the rack.

**To unmount the product from a rack**

1. Loosen the screws at the rack brackets.

2. Bring the lifting equipment to shelf height.

3. Remove the product from the rack.

4. If placing the product on a bench top again, unmount the adapter kit from the prod-
   uct. Follow the instructions provided with the adapter kit.

## 3.5 Considerations for test setup

**Cable selection and electromagnetic interference (EMI)**

Electromagnetic interference (EMI) can affect the measurement results.

To suppress electromagnetic radiation during operation:

- Use high-quality shielded cables, for example, double-shielded RF and LAN cables.
- Always terminate open cable ends.
- Ensure that connected external devices comply with EMC regulations.

**Signal input and output levels**

Information on signal levels is provided in the data sheet. Keep the signal levels within the specified ranges to avoid damage to the product and connected devices.

**Network connections**

Before connecting the product to a local area network (LAN), consider the following:

- Install the latest software to reduce security risks.
- For internet or remote access, use secured connections if applicable.
- Ensure that the network settings comply with the security policies of your company. Contact your local system administrator or IT department before connecting your product to your company LAN.
- When connected to the LAN, the product can potentially be accessed from the internet, which can be a security risk. For example, attackers might misuse or damage the product.

## 3.6 Connecting to power

The R&S QAT provides an AC power connector on the rear panel.

You can use different AC power voltages. The R&S QAT adapts itself automatically. Refer to the datasheet for the requirements of voltage and frequency.

For safety information, see "Connecting to power" on page 6.

1. Plug the AC power cable into the AC power connector on the rear panel of the product. Only use the AC power cable delivered with the product.

2. Plug the AC power cable into a power outlet with ground contact.

    The required ratings are listed next to the AC power connector and in the data sheet.

3. Install the remaining cables before switching on the product.

## 3.7  Switching on or off

*Table 3-1: Overview of power states*

| Status | LED | Position of power switch |
|---|---|---|
| Off | ⚪ gray | [0] |
| Standby | 🟠 orange | [I] |
| Ready | 🟢 green | [I] |

**To switch on the R&S QAT**

The R&S QAT is off but connected to power.

1.  Set the switch on the power supply to position [I].

    The LED of the Power key turns orange.

2.  Press the Power key.

    The LED turns green. The R&S QAT boots.

**To shut down the R&S QAT**

The R&S QAT is in the ready state.

►  Press the [Power] key.

    The operating system shuts down. The LED turns orange.

**To disconnect from power**

The R&S QAT is in the standby state.

1.  **NOTICE!** Risk of data loss. If you disconnect the product from power when it is in the ready state, you can lose settings and data. Shut it down first.

    Set the switch on the power supply to position [0].

    The LED of the Power key is switched off.

2.  Disconnect the product from the power source.

# 4  Instrument tour

In the basic configuration, the front panel contains 96 Tx antennas to transmit a radar signal and 5 Rx antennas.

The rear panel contains the connectors and control elements.
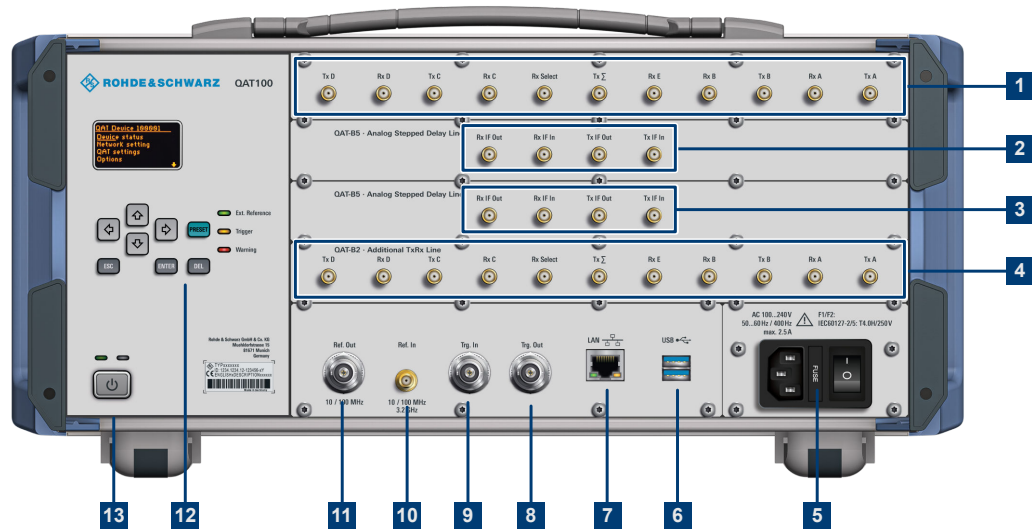


*Figure 4-1: Rear panel overview*

1 = SMA for control of transmit and receive antennas
2 = Analog stepped delay line (optional: R&S QAT-B5)
3 = Analog stepped delay line for optional SMA connectors (optional: R&S QAT-B5)
4 = SMA for control of transmit and receive antennas (optional: R&S QAT-B2)
5 = AC power
6 = USB for service applications
7 = LAN for network connection
8 = BNC connector for trigger output
9 = BNC connector for trigger input
10 = SMA for reference input
11 = BNC for reference output
12 = Display and control elements
13 = Power button
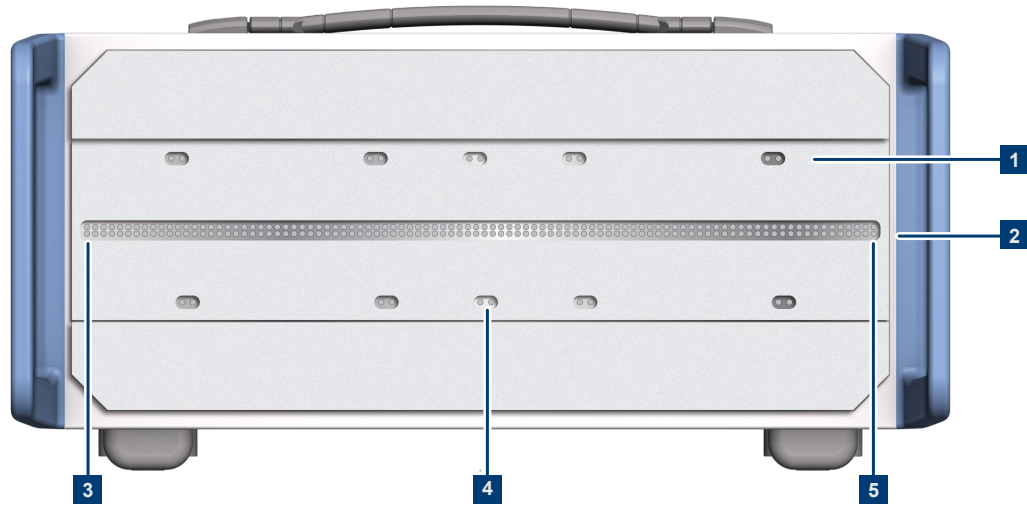
*Figure 4-2: Front panel overview (R&S QAT-B11)*

1 = Receive (Rx) antennas (1 Rx antenna per antenna segment plus one central Rx antenna)
2 = Transmit (Tx) antennas (24 Tx antennas per antenna segment = 96 Tx antennas in total)
3 = Transmit antenna #0
4 = Central Rx antenna
5 = Transmit antenna #95



*Figure 4-3: Front panel overview (R&S QAT-B21)*

1 = Receive (Rx) antennas (24 Rx antenna per antenna segment plus one central Rx antenna)
2 = Transmit (Tx) antennas (24 Tx antennas per antenna segment = 96 Tx antennas in total)
3 = Central Rx antenna

## 4.1  SMA connectors in the antenna lines

**Connector type**: SMA

**Connector label**: see below

**Function**: The R&S QAT has one or two antenna lines. The first antenna line is always installed, while the second line is optional (R&S QAT-B2).

Each antenna line has 11 SMA connectors with the following functionality.

- 4 x receiver outputs for a connection of each segment to a radar echo generator. The connectors are labeled "Rx A" to "Rx D".

- 1 x receiver outputs for a connection of the central Rx antenna to a radar echo generator.
  The connector is labeled "Rx E".

- 4 x transmitter inputs for a connection to a radar echo generator.
  The connectors are labeled "Tx A" to "Tx D".

- 1 x transmitter input for a connection to a radar echo generator
  The connector is labeled "Tx $\sum$".

- 1 x receiver output that you can use to:
  - Feed a single receive signal into the radar echo generator
  - Connect another receiving device to analyze the received signal, like a spectrum analyzer.

  The connector is labeled "Rx Select".

For a more comprehensive description and application of the connectors in the antenna lines, see Chapter 5, "Test setups", on page 21.

**Mapping of connectors to antennas**

The R&S QAT has four antenna segments ("A" to "D") that receive and transmit signals and a fifth Rx antenna in the center ("E"). Depending on the configuration, either all segments transmit a shared signal or segments transmit signals independent of each other. All segments always receive signals either way.
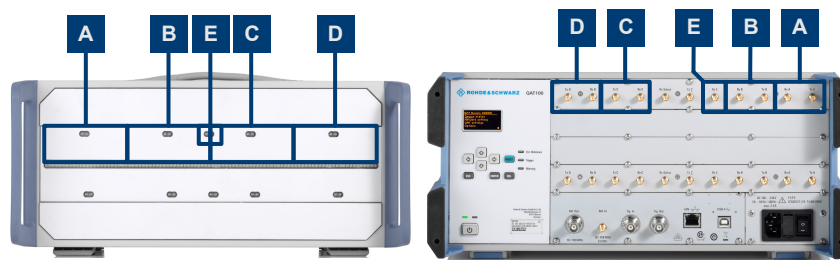


A = Segment A (Tx and Rx)
B = Segment B (Tx and Rx)
C = Segment C (Tx and Rx)
D = Segment D (Tx and Rx)
E = Segment E (Rx only)

## 4.2 Analog stepped delay line

**Connector type**: SMA

**Connector label**: see below

**Function**: The R&S QAT can have one or two optional analog stepped delay lines, one for each antenna line. The analog stepped delay line provides functionality to simulate distances using analog technology using the intermediate frequency.

Each stepped delay line has 4 SMA connectors with the following functionality.

- 1 x receiver output for a connection to a radar echo generator.
  The connector is labeled "Rx IF Out".

- 1 x receiver input for a connection to the "Rx Select" connector on the R&S QAT.
  The connector is labeled "Rx IF In".

- 1 x transmitter output for a connection to the "Tx $\sum$" connector on the R&S QAT.
  The connector is labeled "Tx IF Out".

- 1 x transmitter input for a connection to a radar echo generator.
  The connector is labeled "Tx IF In".

For a detailed description of setup and application of the analog stepped delay line, see Chapter 5.3, "Using the analog stepped delay line", on page 27.

## 4.3 AC power

**Connector type**: IEC 60320-1 C14

**Connector label**: "AC"

**Function**: AC input for a connection to the AC mains supply. You can connect the antenna array to networks with different voltage levels (see datasheet for the supported voltage range). The power supply automatically adapts itself to the voltage level of the power source.

The power cord necessary to connect the panel to the power supply is part of the delivery (with country-specific plug).

For more information about using the AC power supply safely, see "Connecting to power" on page 6.

For more information about supplying the R&S QAT with power, see Chapter 3.6, "Connecting to power", on page 13.

The AC power supply of the R&S QAT also holds a fuse. For instructions on how to replace the fuse, see Chapter 11.1, "Changing fuses", on page 55.

## 4.4 USB 2.0 port

**Connector type**: Standard B

**Connector label**: "USB"

**Function**: USB 2.0 port for service applications.

## 4.5  LAN interface

**Connector type**: RJ45

**Connector label**: "LAN"

**Function**: LAN interface to connect the R&S QAT to a network.

## 4.6  Trigger input & output

**Connector type**: BNC connector

**Connector label**: "Trg In" / "Trg Out"

Reserved for future use.

## 4.7  Reference input

**Connector type**: SMA

**Connector label**: "Ref In"

**Function**: Input for an external frequency reference. Use this connector to synchronize the R&S QAT to the frequency of another device (10 MHz, 100 MHz or 3.2 GHz).

## 4.8  Reference output

**Connector type**: BNC connector

**Connector label**: "Ref Out"

**Function**: Output for the internal frequency reference. Use this connector to synchronize other instruments to the frequency of the R&S QAT (10 MHz or 100 MHz).

## 4.9  Display and control elements

The user interface is displayed in an OLED display.

You can navigate the user interface with various control elements.

- "Preset": Presets the R&S QAT to its default configuration.
- "Esc": Exits a menu and returns to the previous menu level.
- "Enter": Confirms a selection or toggles the state of a parameter.
- "Del": Deletes an entry.
- Cursor keys: Navigate through the user interface.

For an overview of all settings available in the user interface, see Chapter 7, "Function reference", on page 39.

The LEDs next to the control element have the following meaning.

- "Ext. Reference": Illuminated green when an external reference is connected and active.
- "Trigger": Reserved for future use.
- "Warning": Illuminated red when an error occurs (for example when an external reference is selected, but not connected).

## 4.10  Power button

**Function**: Turns the instrument on and off when it is connected to a power source (AC).

For more information about turning the R&S QAT on and off, see Chapter 3.7, "Switching on or off", on page 14.

# 5 Test setups

The R&S QAT is an advanced antenna array that you can use in combination with a radar echo generator to simulate radar objects over-the-air. Because the R&S QAT has independent antennas, it is possible to realistically simulate multiple moving radar objects in a single test setup. Thus, you can, for example, test radar based autonomous driving functions.

## 5.1 Simulating radar objects

In a typical setup, the R&S QAT is the frontend that receives and sends the radar signals. The radar echo generator, for example the R&S AREG800A, is the backend that generates the radar echoes and controls the R&S QAT.

The typical workflow between the two devices goes like this:

1.  The R&S QAT receives a signal from the DUT (radar sensor).

2.  The R&S QAT divides the signal by four and downconverts the signal to an intermediate frequency (IF).

3.  The R&S QAT forwards the IF to the radar echo generator.

4.  The radar echo generator delays and attenuates the IF.

5.  The radar echo generator sends the delayed IF to the R&S QAT.

6.  The R&S QAT upconverts and multiplies the IF.

7.  The R&S QAT routes the signal to one or more of the 96 transmit antennas.

8.  The R&S QAT transmits the signal to the DUT.

9.  The delayed signal travels back to the radar sensor via the air interface and thus tricks the sensor into detecting the artificial object.
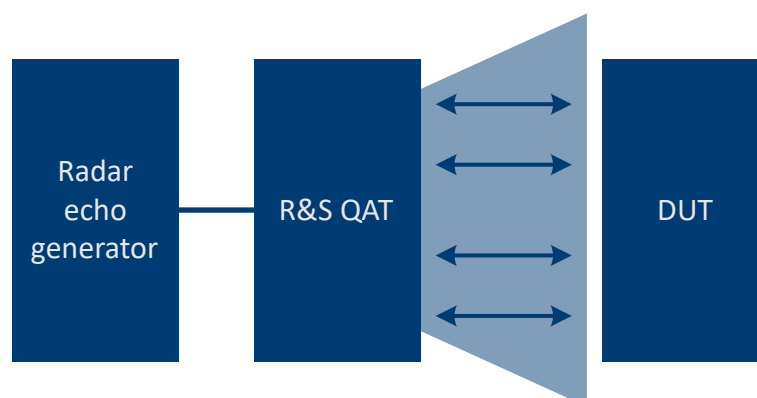


*Figure 5-1: Basic test setup for using a R&S QAT*

The R&S QAT is available with different frontends. One for standard sensor stimulation (R&S QAT-B11), and another for enhanced MIMO compatibility (R&S QAT-B21 or B22).

### 5.1.1 Standard frontend

The base variant of the R&S QAT with a standard frontend contains one line of antennas. The antenna line has five receive antennas and 96 transmit antennas. The antennas in turn belong to one of four antenna segments, which makes one receive antenna and 24 transmit antennas in each segment. An additional independent receive antenna is located in the center of the front panel. The antenna segments and transmit antennas can be controlled individually, if necessary.

Using only the transmit antennas of a certain segment (no connection on the Rx antennas), you can simulate interfering radar signals.

An optional second line of antennas doubles the number of antennas in each R&S QAT. To simulate even more radar objects, you can combine multiple R&S QAT in a single setup.



*Figure 5-2: Antenna array layout as seen from the standard front panel*

Rx = 1 Rx antenna in each antenna segment (plus a single individual anntenna in the center)
Tx = 24 Tx antennas in each antenna segment

### 5.1.2 MIMO frontends

MIMO frontends are similar to standard frontends. You can equip the R&S QAT with one line of antennas (R&S QAT-B21). The main difference from a measurement perspective is that each antenna line in a MIMO frontend contains 96 receive antennas instead of only 5. The number of transmit antennas is the same.

Like standard frontends, the antennas belong to one of four antenna segments, which makes 24 receive antennas and 24 transmit antennas in each segment. The increased number of receive antennas allow you to stimulate MIMO radars by minimizing the distance between the receive and transmit antennas.

However, you can select only one antenna in each segment that sends a signal at a time, so you can simulate four radar signals at the same time. Note that receive and transmit antennas are bundled into pairs - only the receive antenna paired with the transmit antenna that sends a signal receives the signal.

Similar to the standard frontend, the MIMO frontend contains one additional receive antenna in the center.

Measurement setups and their configuration (for example selecting which antenna is active in each segment) are otherwise the same for both frontends.
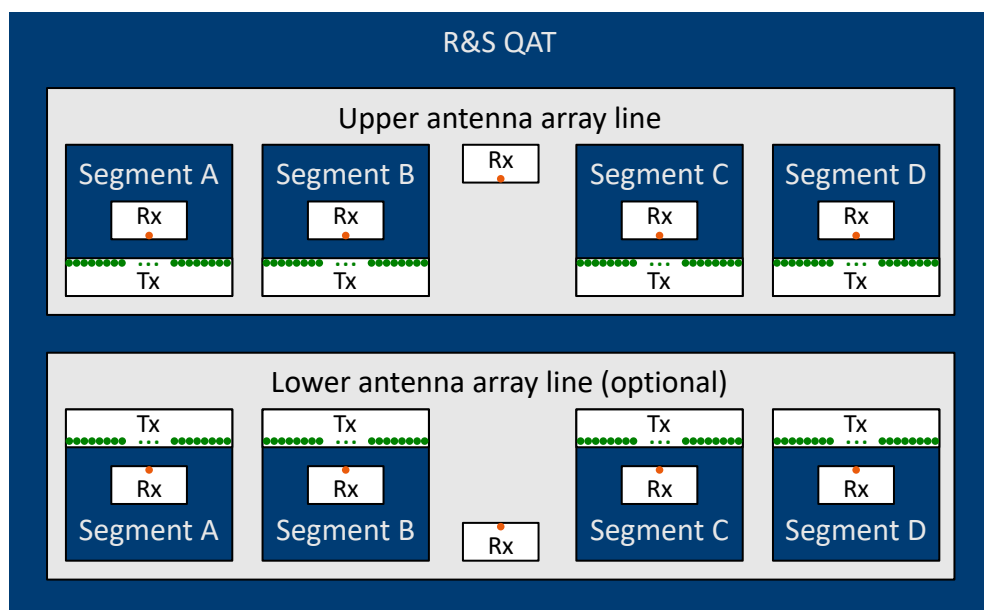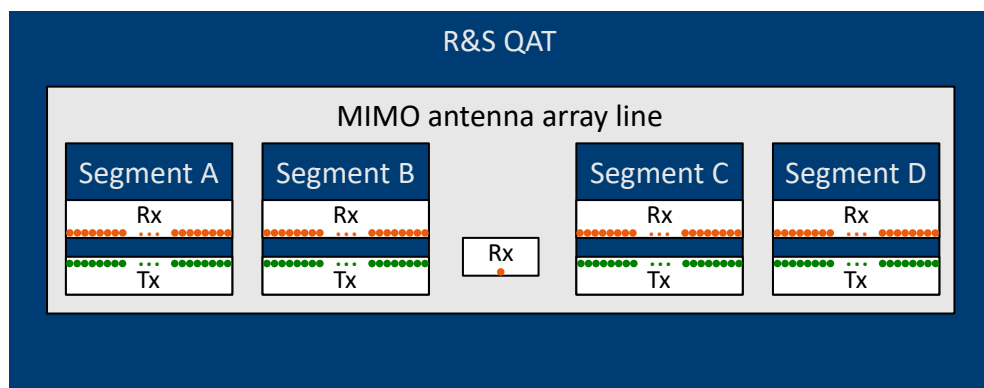


*Figure 5-3: Antenna array layout as seen from the standard front panel*

Rx = 24 Rx antenna in each antenna segment (plus a single individual antenna in the center)
Tx = 24 Tx antennas in each antenna segment

### 5.1.3  Possible test setups

You can configure the R&S QAT such that the antenna segments simulate a single object (line mode) or use antenna segments individually to simulate several objects (segment mode). This allows for the following basic scenarios.

- Line mode: R&S QAT with a single antenna array line:
  Simulate 1 object by using one or more antennas to simulate that object.

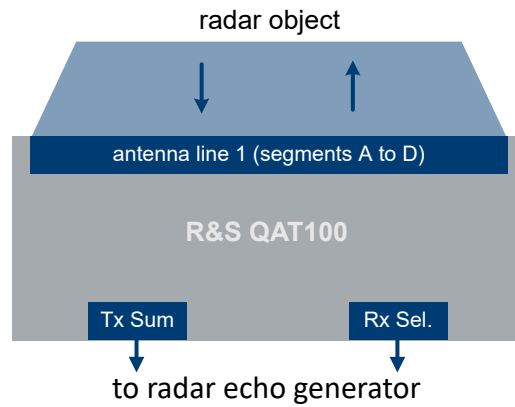*Figure 5-4: Top view of the R&S QAT*

- Line mode: R&S QAT with two antenna array lines:
  Simulate 2 objects by using one or more antennas in each line to simulate those objects.
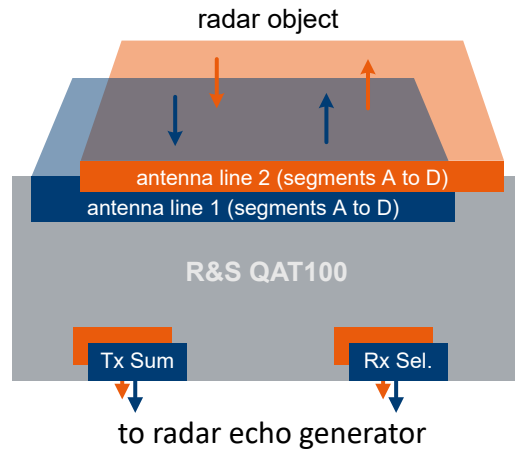


*Figure 5-5: Top view of the R&S QAT*

- Segment mode: R&S QAT with one or two antenna array lines:
  Simulate up to 8 objects by using each antenna segment for one object.
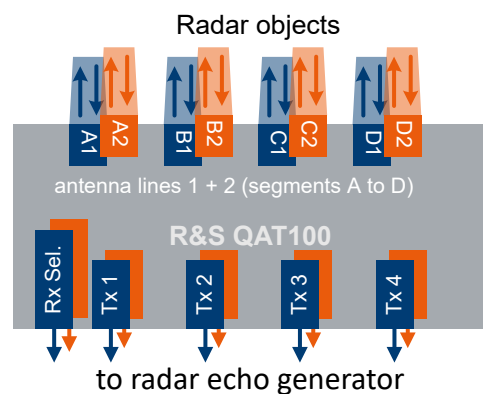


*Figure 5-6: Top view of the R&S QAT*

- Segment mode: Several R&S QAT with one or two antenna array lines:
  Simulate more than 8 objects by using each antenna segment for one object.
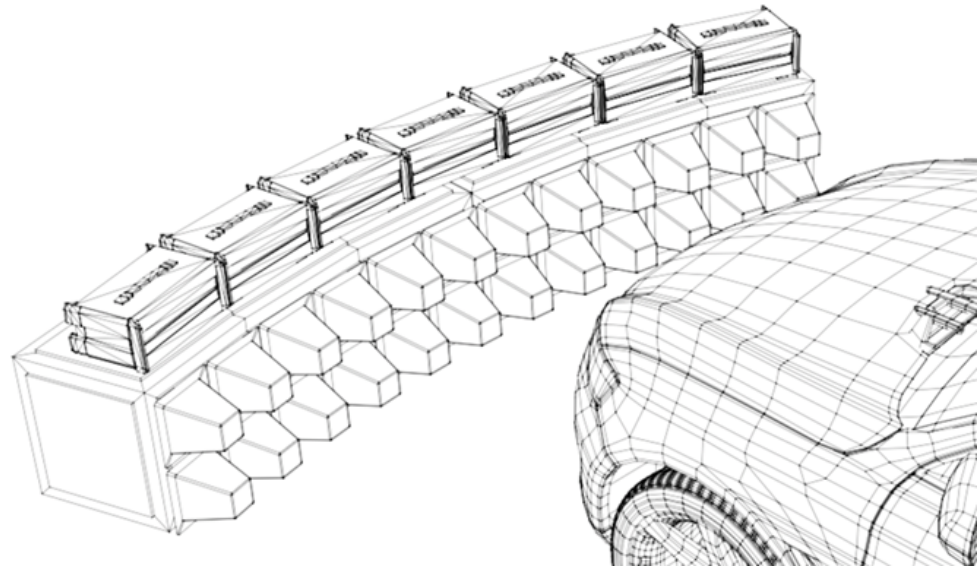


Depending on the number of transmit antennas you want to use, this setup requires more than one radar echo generator, because each R&S AREG800A supports up to eight independent IF paths.
When you use more than one R&S QAT, we recommend to synchronize the frequency of all R&S QAT. One of the R&S QAT is the primary antenna array that supplies the reference frequency for the other R&S QAT.
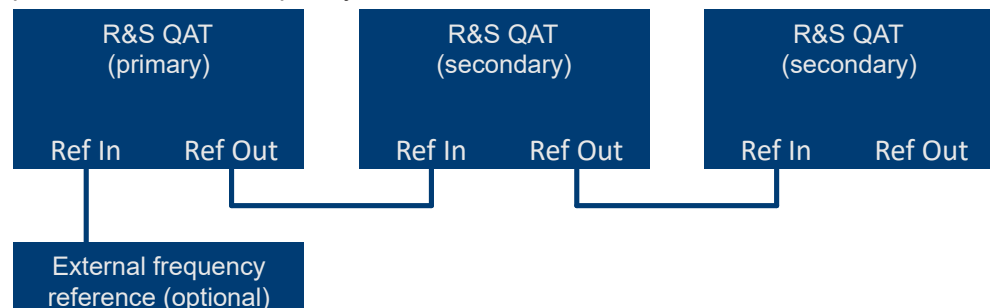


When you use more than one R&S QAT, we recommend using an uneven number of R&S QAT. Using an uneven number of R&S QAT makes sure that a receive antenna of the R&S QAT is in the center of the field-of-view. This setup avoids gaps in the center of the field of view.

### 5.1.4  Field of view

The R&S QAT has a variable field of view and angular resolution that depends on the setup. You can calculate it as follows using the mechanical dimensions of the R&S QAT. Each antenna line has a length of 351 mm with the antennas spaced 3.7 mm apart.

Field of view: $\alpha = 2 * \tan^{-1} (351 \text{ mm} / d)$

Angular resolution: $\Delta\alpha = \tan^{-1}(3.7\ mm\ /\ d)$

with d being the distance between front panel of the R&S QAT and the radar sensor.

*Table 5-1: Examples of field of views and resolutions at varying distances*

| Distance (d) | Field of view (α) | Resolution (Δα) |
|---|---|---|
| 500 mm | 38.7° | 0.42° |
| 700 mm | 28.1° | 0.30° |
| 1000 mm | 19.9° | 0.21° |
| 1500 mm | 13.3° | 0.14° |
| 2100 mm | 10.0° | 0.10° |

## 5.2 Connecting a radar echo generator

The number and types of connections to the radar echo generator depend on the complexity of your test setup. The complexity in turn depends on, for example, the number of simulated radar objects, the number of R&S QAT in your test setup or the number of receive antennas you want to actually use (receive antennas do always receive, but forward the signal only if they are connected to the backend).

Note that, depending on the number of antenna segments you want to control individually, the radar echo generator must have a corresponding number of inputs.

1. Connect the R&S QAT to the LAN.

2. Connect the Tx connectors to the "Tx IF Out" of the radar echo generator.
   There are two ways to use the Tx connectors:
   - Variant 1:
     Connect the transmit signal to the "Tx ∑" connector. In that case, all transmit antennas share the same signal.
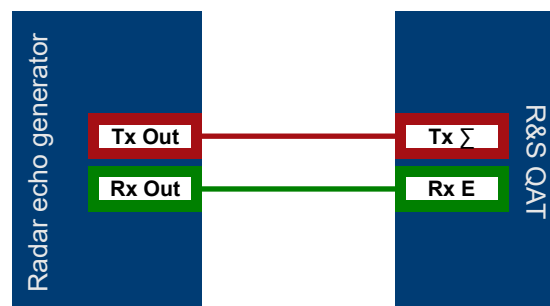


   - Variant 2:
     Connect the transmit signal to the "Tx A" to "Tx D" connector. In that case, each antenna segment can transmit a different signal.
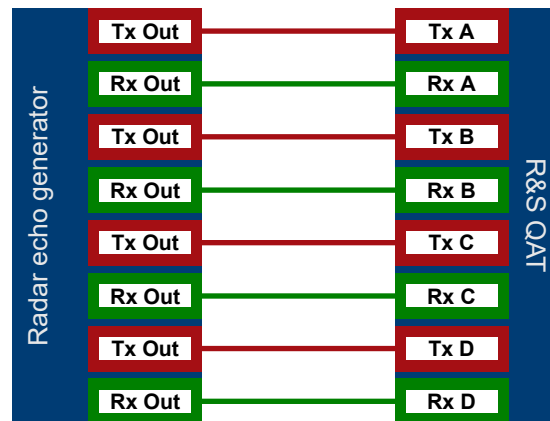
3.  Connect the Rx antennas to the "Rx IF In" of the radar echo generator as required.
    Keep in mind that the receive antennas always receive the signal.
    If you want to feed only a single receive signal into the radar echo generator, con-
    nect the "Rx Select" to one "Rx IF In".
    You can also use the "Rx Select" connector to connect other external devices like a
    spectrum analyzer.

4.  Connect the frequency reference (input or output) to the radar echo generator if
    you want to synchronize the reference frequencies.

    For more information about configuring the interaction between R&S QAT and
    radar echo generator, refer to the user documentation of the radar echo generator.

## 5.3 Using the analog stepped delay line

The optional analog stepped delay line (ASDL, R&S QAT-B5) provides functionality to
simulate radar objects at very short distances from 2 m up to about 13 m that are chal-
lenging for a radar echo generator to simulate. Refer to the datasheet for exact values
that the ASDL can simulate.

You can install up to two ASDLs in a R&S QAT, one for each antenna line. The ASDLs
are located directly below the upper antenna line or directly above the lower antenna
line. This allows for an easy connection between the two components.

The ASDL is an analog component that simulates distances by adding a certain delay
to the signal. The signal runs over the line included in the hardware for a certain
amount of time until the delay corresponding to a certain distance has been reached
and the signal is forwarded to the radar echo generator. The typical workflow described
in Chapter 5.1, "Simulating radar objects", on page 21 changes a little when you use
the ASDL.

1.  The R&S QAT receives a signal from the DUT (radar sensor).

2.  The R&S QAT divides the signal by four and downconverts the signal to an inter-
    mediate frequency (IF).

3.  The R&S QAT runs the signal over the ASDL for a certain amount of time.

4.  The R&S QAT forwards the delayed IF to the radar echo generator.

5.  The radar echo generator attenuates the delayed IF.

6.  The radar echo generator sends the attenuated IF to the R&S QAT.

7.  The R&S QAT upconverts and multiplies the IF.

8.  The R&S QAT routes the signal to one or more of the 96 transmit antennas.

9.  The R&S QAT transmits the signal to the DUT.

10. The delayed signal travels back to the radar sensor via the air interface and thus tricks the sensor into detecting the artificial object.

(i) If you want to retrofit the analog stepped delay line, contact your Rohde & Schwarz representative. Only service personnel authorized by Rohde & Schwarz are allowed to open the R&S QAT and install the component.

**Basic connections for the ASDL**

A connection between the antenna line and the ASDL is independent of the connection to the radar echo generator.

1.  Connect the "Rx IF In" connector of the ASDL to the "Rx Select" connector with the bridge that is part of the delivery.

2.  Connect the "Tx IF Out" connector of the ASDL to the "Rx $\sum$" connector with the bridge that is part of the delivery.

**Connecting a radar echo generator**

The number and types of connections to the radar echo generator depend on the complexity of your test setup. The complexity in turn depends on, for example, the number of simulated radar objects, the number of R&S QAT in your test setup or the number of receive antennas you want to actually use (receive antennas do always receive, but forward the signal only if they are connected to the backend).

Note that, depending on the number of antenna segments you want to control individually, the radar echo generator must have a corresponding number of delay paths.

1.  Connect the R&S QAT to the LAN.

2.  Connect the R&S QAT to the IF connectors of the radar echo generator.
    There are two typical ways to connect the R&S QAT to the radar echo generator:

a) Variant 1: All transmit antennas of the R&S QAT share the same signal (line mode).
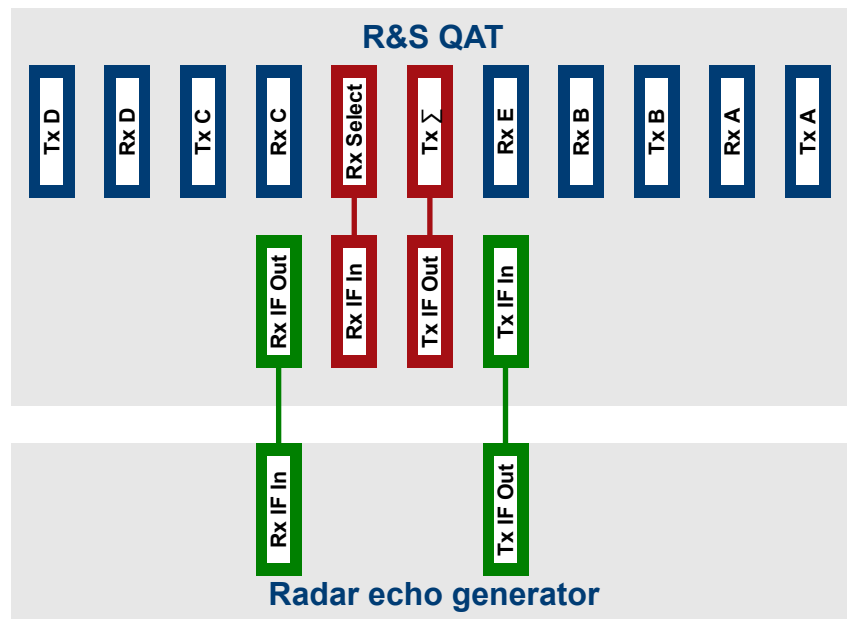


- Connect the "Tx IF In" of the R&S QAT's ASDL to "Tx IF Out" on the radar echo generator.
  The radar echo generator feeds a single signal into the R&S QAT. The R&S QAT distributes this signal to all transmit antennas.
- Connect the "Rx IF Out" of the R&S QAT's ASDL to the "Rx IF In" on the radar echo generator.
  The R&S QAT receives the radar signal on the currently selected receive antenna and forwards that signal to the radar echo generator.

b)  Variant 2: The segments in each antenna line are independent.
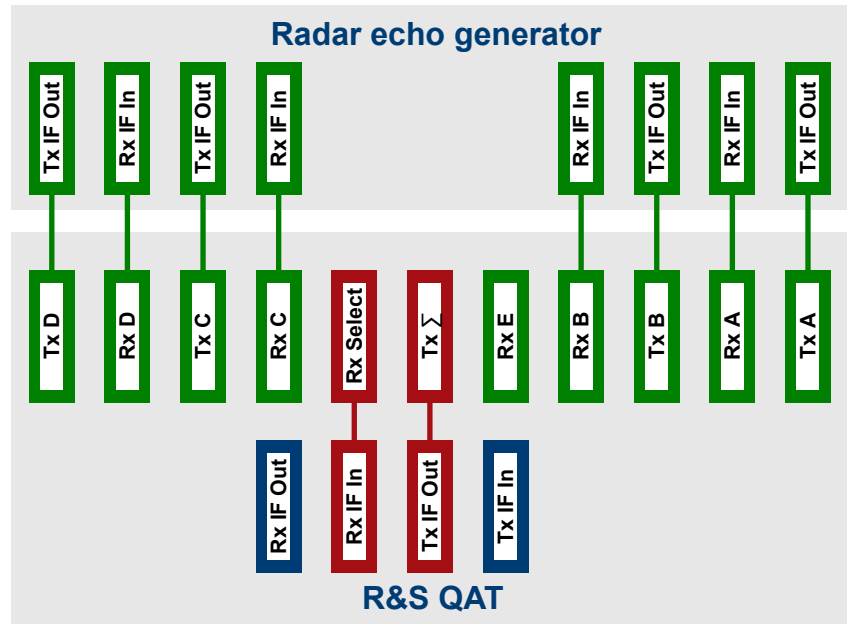


- Connect the Tx antennas of the R&S QAT's antenna line to the "Tx IF Out" connectors of the radar echo generator. The number of connections depends on the number of different radar signals you want to transmit.
- Connect the Rx antennas to the "Rx IF In" of the radar echo generator as required. Keep in mind that the receive antennas always receive the signal. If you want to feed only a single receive signal into the radar echo generator, connect the "Rx Select" to one "Rx IF In".
  You can also use the "Rx Select" connector to connect other external devices like a spectrum analyzer.

3.  Connect the frequency reference (input or output) to the radar echo generator if you want to synchronize the reference frequencies.

    For more information about configuring the interaction between R&S QAT and radar echo generator, refer to the user documentation of the radar echo generator.

**Using the R&S QAT in a standalone setup**

When you equip the R&S QAT with the optional ASDL, you can use the R&S QAT as a standalone radar echo simulator. In that case the workflow excludes the radar echo generator described above. No additional equipment is necessary.

1.  The R&S QAT receives a signal from the DUT (radar sensor).

2.  The R&S QAT divides the signal by four and downconverts the signal to an intermediate frequency (IF).

3.  The R&S QAT runs the signal over the ASDL for a certain amount of time.

4.  The R&S QAT attenuates the signal .

5.  The R&S QAT upconverts and multiplies the IF.

6.  The R&S QAT routes the signal to one or more of the 96 transmit antennas.

7.  The R&S QAT transmits the signal to the DUT.

## 5.4  Attaching the shielding system for one R&S QAT

The optional shielding system for a single R&S QAT (R&S QAT-Z50) prevents the radar from receiving interfering signals from other radar devices and significantly reduces the amount of unwanted reflections from the environment. It also protects other devices against interference from the radar signals of the radar under test. To attach the shielding system, you have to remove the handles and instead screw the shielding system to the R&S QAT.

The shielding system is delivered as a single piece.

Additional extensions (R&S QAT-Z51) allow you to increase the distance between R&S QAT and DUT.

Using the R&S QAT requires a shielded environment to protect other devices against interference from the radar signals. Therefore, you must either attach the shielding system or use the R&S QAT in an anechoic chamber or a faraday cage.

Stop operating the R&S QAT if you receive any reports of interference.

1.  Screw off the handles on either side of the R&S QAT using a Torx screwdriver (4 screws, size T20).
    Store the handles in a safe place.

*Figure 5-7: Removing the handles*

2. Clip the absorber strips that are part of the delivery to the inside of each side of the shielding system and extensions (if you have any). The absorber point to the inside of the shielding system. The four clips you need to attach the absorber strips are part of the delivery.
The absorber strips are necessary to keep the unwanted emissions at a minimum.
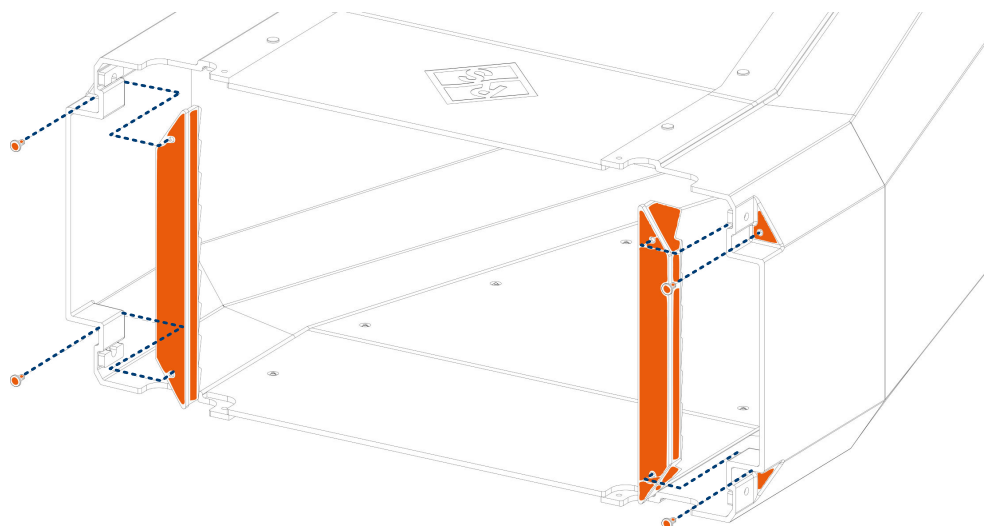


*Figure 5-8: Attaching absorber strips*

3. Optional (for larger distances between R&S QAT and DUT): Attach the extensions to the shielding system with a Torx screwdriver. You can attach several extensions, depending on your test setup.

*Figure 5-9: Attaching extensions*

4. Screw the shielding system to the R&S QAT using the screws from the handles and a Torx screwdriver (4 screws, size 20).
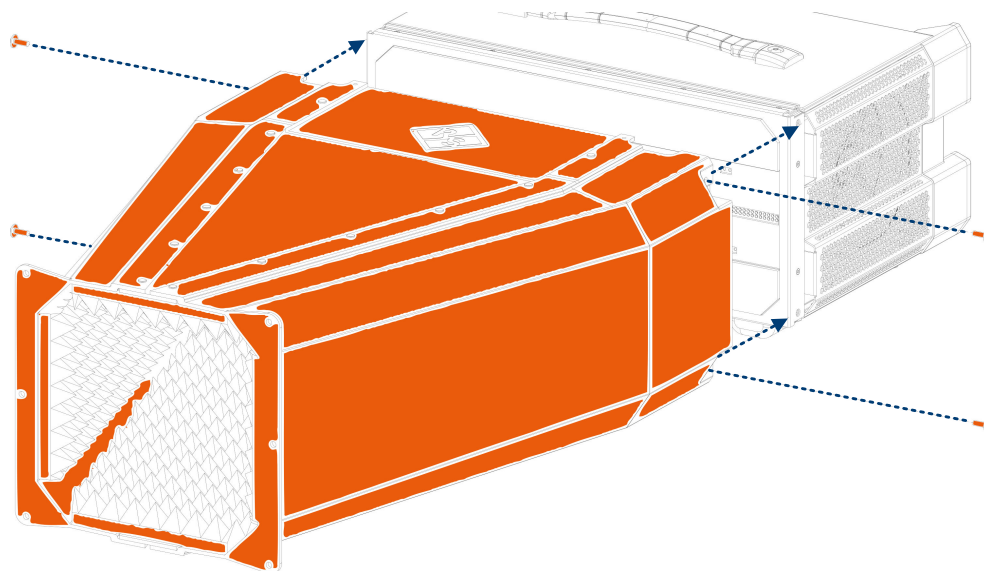


*Figure 5-10: Attaching the shielding system*

When setting up the R&S QAT with the shielding system, make sure that there is no empty space between the shielding system and the DUT to protect other devices from interfering radar signals.
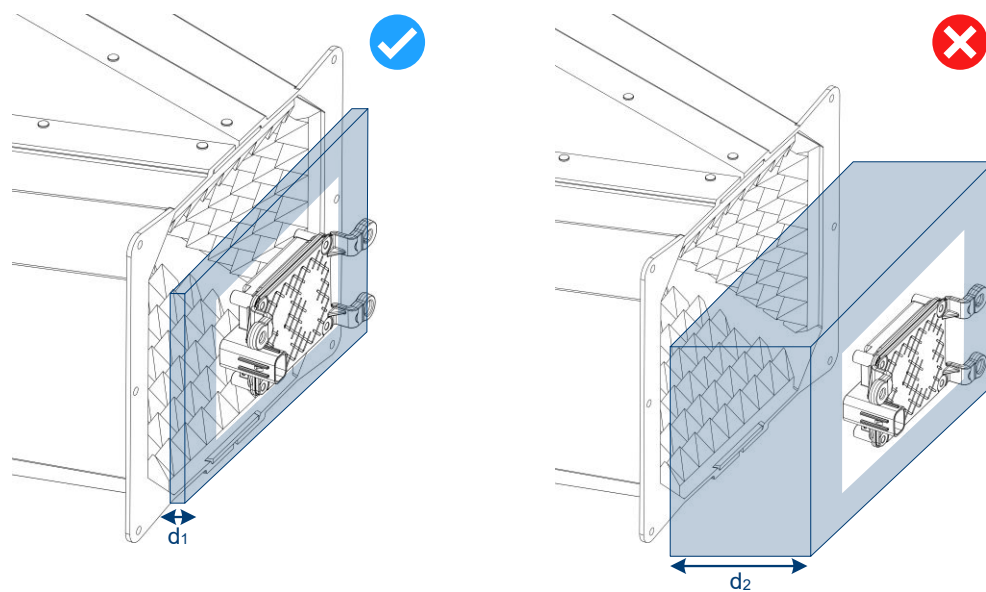
*Figure 5-11: Distance between shielding system and DUT*

$d_1$ = Position OK: DUT directly in front of shielding system
$d_2$ = Position not OK: DUT too far from shielding system

# 6 Instrument configuration

The R&S QAT provides various settings for the test setups described in Chapter 5, "Test setups", on page 21. You can access all settings via the controls on the rear panel of the R&S QAT. The currently selected menu entry is underlined.

- For an overview of controls and what they do, see Chapter 4.9, "Display and control elements", on page 19.
- For an overview of all settings available in the user interface of the R&S QAT, see Chapter 7, "Function reference", on page 39.

**Checking the device status**

The device status menu contains information about the device status (indicates if the R&S QAT is running properly), hardware and software version and serial number of the R&S QAT.

► Select "Device Status" from the main menu.

**Configuring a LAN connection**

If you are connecting your R&S QAT to a LAN, you have to define the network properties.

1. Select "Network" from the main menu.

2. Turn "DHCP" (dynamic IP address assignment) on or off.
   When dynamic IP address assignment is on, the network automatically assigns a free IP address to the connected R&S QAT.

3. When you turn off DHCP, configure the IP address (IPv4), subnet mask and gateway manually.

   - Use the left and right cursor keys to select a digit in the number.
   - Use the up and down cursor keys to increase or decrease a digit.
   - Use the "Enter" key to confirm your entry.

   Refer to your system administrator for information about network properties you can use.

**Configuring a frequency reference**

A reference frequency synchronizes the frequency between devices if the test setup consists of more than one device. You can use the R&S QAT as the reference and feed its frequency to other devices or connect an external device that supplies the frequency.

1. Select "QAT Settings" from the main menu.

2. Select "Reference" > "Input" to select the frequency applied to the reference input. The reference input synchronizes the R&S QAT to the frequency of another device.

   - "Internal": No external reference connected.

- ● "Ext 10 MHz" / "Ext 100 MHz" / "Ext 3.2 GHz": Frequency supplied by an external reference. Note that 3.2 GHz is supported only if you are using an R&S AREG800 as the reference.

3. Select "Reference" > "Output" to select the frequency available at the reference output. The reference output synchronizes other devices to the frequency of the R&S QAT.
   The R&S QAT can provide frequencies of "10 MHz" and "100 MHz".

**Selecting the radar band**

1. Select "QAT Settings" from the main menu.

2. Select "Radar Band".
   The R&S QAT supports the following radar bands.

   - ● "Radar Band A" (76 GHz - 77 GHz)
   - ● "Radar Band B" (77 GHz - 81 GHz)
   - ● "Radar Band C" (76 GHz - 80 GHz)

**Controlling the transmit antennas**

1. Select "QAT Settings" from the main menu.

2. Define the transmission method.

   a) Select "Tx Config".
   b) Select the antenna line you want to configure.

      - ● "Tx Input A": Main antenna line.
      - ● "Tx Input B": Optional antenna line.

   c) For the selected antenna line, select the signal transmission method. The preferred method depends on your test setup and how many radar objects you need to simulate.

      - ● "Tx In Separate": Different signal on each antenna segment.
        Use this setting to simulate multiple radar objects.
      - ● "Tx In Sum": Same signal on all antenna segments.
        Use this setting to simulate a single radar object.

3. Control the state of the transmission antennas.
   The R&S QAT has 96 transmit antennas in each antenna line. You can define the state of each individual antenna.

   a) Select "Tx Channel On / Off".
   b) Select the antenna line you want to configure.

      - ● "TxA": Main antenna line.
      - ● "Tx B": Optional antenna line.

   c) Select one of the 96 transmit antennas with the left and right cursor keys. Note that counting of transmit antennas in the user interface starts with "Tx (0)" and ends with "Tx (95)".

d) Toggle the state of the selected antenna with the "Enter" key.
By default, all transmitt antennas are off. Selecting an antenna with the cursor keys automatically turns on that antenna.

**Controlling the receive antennas**

Basically, the five receive antennas on the antenna line are always active and receive the radar signal.

However, you can use the "Rx Select" connector to feed one of the receive signals in to an external device.

1. Select "QAT Settings" from the main menu.

2. Select the antenna line you want to configure.

   ● "Rx Select A": Main antenna line.
   ● "Rx Select B": Optional antenna line.

3. Select "Rx Select A" to "Rx Select E".
   The R&S QAT routes the signal of the selected Rx antenna to the "Rx Select" connector.

**Configuring the analog stepped delay line**

If you have installed the analog stepped delay line, you can configure its characteristics, depending on your setup.

1. Select "QAT Settings" from the main menu.

2. Select the analog stepped delay line you want to configure.

   ● "ASDL A": First analog stepped delay line.
   ● "ASDL B": Second analog stepped delay line.

   Both analog stepped delay lines are optional.

3. Define the signal "Delay" with the up and down cursors.
   The delay is a value between 0 and 129. Each step corresponds to a distance of 10 cm (therefore a value of 129 corresponds to 12.9 m).

4. By default, the R&S QAT automatically attenuates the signal based on the selected delay.
   Define an additional "Attenuation" offset (in dB) with the left and right cursor keys. The attenuation is a value between 0 and 127 dB in 1 dB steps.

   **Note:** When you control the R&S QAT remotely using SCPI commands, you can also define a custom attenuation that overrides the automatic attenuation.

5. Select the signal source with the "Enter" key.

   ● "Int": R&S QAT as a standalone simulator. Signal runs between the ASDL to the antenna lines.
   ● "Ext": R&S QAT connected to a radar echo generator. Signal runs over the "Rx IF Out" and "Tx IF In" connectors to an external radar echo generator.

Note that when you switch back from an external to an internal source, the delay is automatically reset to 0.

# 7  Function reference

| Device Status | | | |
|---|---|---|---|
| Network | DHCP | | |
| | IP | | |
| | Sub | | |
| | GW | | |
| QAT Settings | Rx Select A | Rx Select A | |
| | | Rx Select B | |
| | | Rx Select C | |
| | | Rx Select D | |
| | | Rx Select E | |
| | Rx Select B[1] | Rx Select A | |
| | | Rx Select B | |
| | | Rx Select C | |
| | | Rx Select D | |
| | | Rx Select E | |
| | Tx Config | Tx Input A | Tx in Separate |
| | | | Tx in Sum |
| | | Tx Input B[1] | Tx in Separate |
| | | | Tx in Sum |
| | Tx Channel On / Off | A Tx | Tx <x> <state> |
| | | B Tx[1] | Tx <x> <state> |
| | Radar Band | Radar Band A | |
| | | Radar Band B | |
| | Options | | |
| | Reference | Input | Intern |
| | | | Ext 10 MHz |
| | | | Ext 100 MHz |
| | | | Ext 3.2 GHz |
| | | Output | 10 MHz |
| | | | 100 MHz |
| | ASDL <x>[2] | ASDL A | Delay |
| | | | Attenuation |

| | | | Int / Ext |
|---|---|---|---|
| | | ASDL B | Delay |
| | | | Attenuation |
| | | | Int / Ext |
| Options[3] | | | |

[1]Available with the optional second antenna line.

[2]Available with the optional analog stepped delay lines.

[3]Contains entries if optional hardware is installed.

# 8 Remote control

## 8.1 Remote control interface and protocol

For the R&S QAT, the remote control interface is the LAN interface. The LAN interface consists of a connector, a network interface card and protocols.

The network card can be operated with the following interfaces:

- 10 Mbit/s Ethernet IEEE 802.3
- 100 Mbit/s Ethernet IEEE 802.3u
- 1Gbit/s Ethernet IEEE 802.3ab

For remote control via a network, the PC and the instrument must be connected via the LAN interface to a common network with TCP/IP network protocol. They are connected using a commercial RJ45 cable (shielded or unshielded twisted pair category 5). The TCP/IP network protocol and the associated network services are preconfigured on the instrument. Software for instrument control and the VISA program library must be installed on the PC (controller).

**IP address**

Only the IP address or a valid DNS host name is required to set up the connection. The host address is part of the "VISA resource string" used by the programs to identify and control the instrument.

The VISA resource string has the form:

```
TCPIP::host address[::LAN device name][::INSTR]
```

where:

- **TCPIP** designates the network protocol used
- **host address** is the IP address or host name of the device
  `inst0` selects the VXI-11 protocol
- **LAN device name** defines the protocol and the instance number of a sub-instrument;
- **INSTR** indicates the instrument resource class (optional)

**Example:**

- Instrument has the IP address *192.1.2.3*; the valid resource string using VXI-11 protocol is:
  ```
  TCPIP::192.1.2.3::INSTR
  ```

ⓘ **Identifying instruments in a network**

If several instruments are connected to the network, each instrument has its own IP address and associated resource string. The controller identifies these instruments by the resource string.

**VISA library**

A VISA installation is a prerequisite for remote control using the LAN interface.

VISA is a standardized software interface library providing input and output functions to communicate with instruments. High level programming platforms use VISA as an intermediate abstraction layer.

The I/O channel (LAN or TCP/IP) is selected at initialization time by one of the following:

- The channel–specific address string ("VISA resource string")
- An appropriately defined VISA alias (short name).

For more information about VISA, refer to the VISA user documentation.

**VXI-11 protocol**

The VXI-11 standard is based on the open network computing remote procedure call (ONC RPC) protocol which in turn relies on TCP/IP at the network/transport layer. The TCP/IP network protocol and the associated network services are preconfigured.

TCP/IP ensures connection-oriented communication, where the order of the exchanged messages is adhered to and interrupted links are identified. With this protocol, messages cannot be lost.

**SCPI compatibility**

SCPI commands (standard commands for programmable instruments) are used for remote control. The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of instrument-specific commands, error handling and the status registers. The tutorial "Automatic Measurement Control - A tutorial on SCPI and IEEE 488.2" from John M. Pieper (R&S order number 0002.3536.00) offers detailed information on concepts and definitions of SCPI. The instrument supports the SCPI version 1999.

Commands that are not taken from the SCPI standard follow the SCPI syntax rules.

**Communication ports**

You have to open several ports in the firewall to be able to communicate via SCPI. By default, these ports are already open on the R&S QAT. If you want to close these ports, you can run a script that closes these ports.

- To close the ports, run the
  script `.\firewall\firewall-disableaccess.bat`.
  Closing the ports disables remote control functionality.
- To reopen the ports, run the script `.\firewall\firewall-setting.bat`.

## 8.2  Remote control commands

### 8.2.1  Common commands

**\*IDN?**

Returns the instrument identification.

**Return values:**

| | |
|---|---|
| <ID> | "Rohde&Schwarz,<device type>,<serial number>,<firmware version><CR><LF>" |
| **Example:** | `Rohde&Schwarz,QAT-100,123456,1.00>CR><LF>` |
| **Usage:** | Query only |

**\*OPT**

Queries the options included in the instrument. For a list of all available options and their description, refer to the data sheet.

**Return values:**

| | |
|---|---|
| <Options> | The query returns a list of options. The options are returned at fixed positions in a comma-separated string. A zero is returned for options that are not installed. |

**\*RST**

Sets the instrument to a defined default status. The default settings are indicated in the description of commands.

| | |
|---|---|
| **Usage:** | Event |

**\*SERial**

Returns the serial number of the R&S QAT

**Return values:**
<SerialNo>

## 8.2.2 Network configuration

**SET:LAN:DHCP:ON**
**SET:LAN:DHCP:OFF**
**SHOW:LAN:DHCP?**

Configures and queries the state of DHCP on the R&S QAT.

**Return values:**

| | |
|---|---|
| <State> | 1 (ON) \| 0 (OFF) |
| **Example:** | See SHOW:LAN:IP? |
| **Usage:** | Query only |

**SET:LAN:SNM** <Gateway>
**SHOW:LAN:SNMask?**

Returns the subnet mask of the R&S QAT.

**Return values:**

| | |
|---|---|
| <SubnetMask> | IP address in the format 000.000.000.000. |
| **Example:** | See SHOW:LAN:IP? |
| **Usage:** | Query only |

**SET:LAN:GW** <Gateway>
**SHOW:LAN:GW?**

Defines or queries the standard gateway for the R&S QAT.

**Return values:**

| | |
|---|---|
| <Gateway> | Gateway address in the format 000.000.000.000. |

**Example:**             See `SHOW:LAN:IP?`

**Usage:**               Query only

---

**SET:LAN:HOST:NAMe** <HostName>
**SHOW:LAN:HOST:NAME?**

Defines or queries the host name of the R&S QAT.

**Parameters:**
<HostName>               String that contains the hostname.
                         The default host name is `QAT100<SerialNumber>`

**Example:**             //Set and query host name
                         `SET:LAN:HOST:NAME 'QATHostName'`
                         `SHOW:LAN:HOST:NAME?`

**Usage:**               Query only

---

**SET:LAN:INIT**

Activates the LAN configuration of the R&S QAT

**Example:**             See `SHOW:LAN:IP?`

**Usage:**               Event

---

**SET:LAN:IP** <IPAddress>
**SHOW:LAN:IP?**

Defines or queries the IP address of the R&S QAT.

Prerequisites for this command

● Turn off DHCP (`SHOW:LAN:DHCP?`).

**Return values:**
<IPAddress>              IP address in the format 000.000.000.000.

**Example:**             //Configure network properties
                         `Show:LAN:MAC:ADDR?`
                         `SET:LAN:DHCP?`
                         `SET:LAN:DHCP:OFF`
                         `SET:LAN:GW 192.0.2.0`
                         `SET:LAN:SNM 255.255.0.0`
                         `SET:LAN:IP 192.0.2.0`
                         `SET:LAN:INIT`
                         `WRITE:MXINI`

**Usage:**               Query only

---

**SHOW:LAN:MAC:ADDRess??**

Queries the MAC address of the R&S QAT.

**Return values:**

<MACAddress>

| | |
|---|---|
| **Example:** | See SHOW:LAN:IP? |
| **Usage:** | Query only |

---

### WRITe:MXINi

Writes the LAN settings to the non-volatile memory of the R&S QAT and are therefore kept after a restart of the R&S QAT.

| | |
|---|---|
| **Example:** | See SHOW:LAN:IP? |
| **Usage:** | Event |

## 8.2.3 System configuration

---

### HANDshake?

Queries the state of the handshake function.

**Return values:**

| | |
|---|---|
| State | ON | OFF | 1 | 0 |

| | |
|---|---|
| **Example:** | //Turn on handshake function and query state |
| | HAND:ON |
| | HAND? |
| **Usage:** | Query only |

---

### HANDshake:ON
### HANDshake:OFF

Turns the handshake function on and off.

If on, a successful execution of a command that has no query is confirmed by a corresponding message.

| | |
|---|---|
| **Example:** | //Turn on handshake |
| | HAND:ON |
| | //Select transmit antenna |
| | ANT:TX_A:ON 12 |
| | would return: |
| | "TX_A 12 ON"<CR><LF> |

| | |
|---|---|
| **Example:** | //Turn off handshake |
| | `HAND:OFF` |
| | //Select transmit antenna |
| | `ANT:TX_A:ON 12` |
| | would return nothing |
| **Usage:** | Event |

---

### SYSTem:CLEar

Clears the error list of the R&S QAT.

| | |
|---|---|
| **Example:** | //Query and clear error list |
| | `SYST:ERR?` |
| | `SYST:CLE` |
| **Usage:** | Event |

---

### SYSTem:ERRor?

Queries the error list of the R&S QAT.

**Return values:**

| | |
|---|---|
| <ErrorList> | List of errors. |

| | |
|---|---|
| **Example:** | //Query error list |
| | `SYST:ERR?` |
| **Usage:** | Query only |

## 8.2.4 Transmit antenna configuration

---

**ANT:TX_<al>:ON** <Antenna>
**ANT:TX_<al>:OFF** <Antenna>

Turns a specific transmit antenna on or off.

**Suffix:**

| | |
|---|---|
| <al> | A \| B |
| | Antenna line (A = upper line, B = optional lower line) |

**Parameters:**

| | | |
|---|---|---|
| <Antenna> | Range: | 0 to 95 |

| **Example:** | //Configure transmit antennas in line A |
|---|---|
| | `ANT:TX_A:ON 12` |
| | `ANT:TX_A:ON 24` |
| | `ANT:TX_A:OFF 6` |
| | `ANT:TX_A:OFF 18` |

**ANT:TX_<al>:SWITch** <Antenna>

Turns on a single transmit antenna and simultenously turns off all other transmit antennas.

**Suffix:**

| <al> | A \| B |
|---|---|
| | Antenna line (A = upper line, B = optional lower line) |

**Parameters:**

| <Antenna> | Range: 0 to 95 |
|---|---|

| **Example:** | //Turn on transmit antenna 24 in line A |
|---|---|
| | `ANT:TX_A:SWIT 24` |

**TX_<al>:TX_IN?**
**TX_<al>:TX_IN:<inp>**

Selects or queries the Tx input the radar generator is connected to.

**Suffix:**

| <al> | A \| B |
|---|---|
| | Antenna line (A = upper line, B = optional lower line) |
| <inp> | SUM \| ABC |
| | Tx input (SUM = Tx∑, ABC = Tx A - D) |

| **Example:** | //Select Tx input for line A |
|---|---|
| | `TX_A:TX_IN:SUM` |

| **Usage:** | Event |
|---|---|

## 8.2.5 Receive antenna configuration

**RX_<al>:SELect?**
**RX_<al>:SELect:<ch>** <Antenna>

Selects or queries the active receive antenna.

**Suffix:**

| | |
|---|---|
| <al> | A \| B |
| | Antenna line (A = upper line, B = optional lower line) |
| <ch> | A \| B \| C \| D \| E |
| | Receive antenna |
| **Example:** | //Select Rx antenna B in line A as the receiving antenna |
| | RX_A:SEL:B |
| **Usage:** | Event |

---

**RX_<al>:RADarband?**
**RX_<al>:RADarband:<band>**

Selects a radarband of the corresponding cluster.

**Suffix:**

| | |
|---|---|
| <al> | A \| B |
| | Antenna line (A = upper line, B = optional lower line) |
| <band> | MBR \| SSR \| USR |
| | Radar band |
| **Example:** | //Select radar band for line A |
| | RX_A:RAD:MBR |
| **Usage:** | Setting only |

## 8.2.6 Frequency reference configuration

**ROSCillator:INTern**

Selects the internal reference frequency.

| | |
|---|---|
| **Example:** | //Select internal reference |
| | ROSC:INT |
| **Usage:** | Event |

---

**ROSCillator:EXTern** <Frequency>

Selects an external reference frequency.

**Parameters:**

| | |
|---|---|
| <Frequency> | **10MHZ** |
| | 10 MHz reference frequency |
| | **100MHZ** |
| | 100 MHz reference frequency |

**3200MHZ**

3.2 GHz reference frequency

**Example:**    //Select external reference

ROSC:EXT 10MHZ

---

**ROSCillator:OUTPut** <Frequency>

Selects the output reference frequency.

**Parameters:**

<Frequency>    **10MHZ**

Select 10 MHz reference

**100MHZ**

Select 100 MHz reference

**Example:**    //Select output reference

ROSC:OUTP 10MHZ

## 8.2.7 ASDL configuration (optional)

---

**ASDL_<asdl>:EXT**

Selects an external signal source for the analog stepped delay line.

**Suffix:**

<asdl>    A | B

Analog stepped delay line (A = upper line, B = lower line)

**Example:**    //Select external signal source for stepped delay line A

ASDL_A:EXT

---

**ASDL_<asdl>:INT**

Selects an internal signal source for the analog stepped delay line.

**Suffix:**

<asdl>    A | B

Analog stepped delay line (A = upper line, B = lower line)

**Example:**    //Select internal signal source for stepped delay line A

ASDL_A:INT

**ASDL_<asdl>:MANual**

Selects custom attenuation mode that overrides the automatic attenuation value.

Use `ASDL_<asdl>:ATTenuation` to define the corresponding attenuation values.

**Suffix:**

| <asdl> | A \| B |
|---|---|
| | Analog stepped delay line (A = upper line, B = lower line) |

**Example:** //Select the attenuation mode for analog stepped delay line A
`ASDL_A:MANual`

**Usage:** Setting only

---

**ASDL_<asdl>:OFFSet**

Selects automatic attenuation mode with an attenuation offset that is added to the automatic attenuation value.

Use `ASDL_<asdl>:ATTenuation` to define the corresponding offset values.

**Suffix:**

| <asdl> | A \| B |
|---|---|
| | Analog stepped delay line (A = upper line, B = lower line) |

**Example:** //Select the attenuation mode for analog stepped delay line A
`ASDL_A:OFFS`

**Usage:** Setting only

---

**ASDL_<asdl>:ATTenuation** <Attenuation>

Defines the attenuation or attenuation offset for the analog stepped delay line.

- `ASDL_<asdl>:MANual`: command defines custom attenuation level.
- `ASDL_<asdl>:OFFSet` = OFFSet: command defines attenuation offset.

**Suffix:**

| <asdl> | A \| B |
|---|---|
| | Analog stepped delay line (A = upper line, B = lower line) |

**Parameters:**

| <Attenuation> | Range: | 0 to 127 |
|---|---|---|
| | *RST: | 0 |
| | Default unit: dB | |

**Example:** //Define attenuation offset of 6 dB for analog stepped delay line A
`ASDL_A:OFFS`
`ASDL_A:ATT 6`

**Example:**         //Define custom attenuation of 12 dB for analog stepped delay line A

```
ASDL_A:MAN
ASDL_A:ATT 12
```

---

**ASDL_&lt;asdl&gt;:DISTance** &lt;Distance&gt;

Defines the distance that the analog stepped delay line simulates.

**Suffix:**

&lt;asdl&gt;        A | B

Analog stepped delay line (A = upper line, B = lower line)

**Parameters:**

&lt;Distance&gt;       Value multiplied by 10 defines the distance in cm, for example a value of 117 = 1170 cm.

Range:     0 to 129
*RST:      0

**Example:**         //Define distance of analog stepped delay line A

```
ASDL_A:DIST 67
```

**Usage:**           Setting only

---

**ASDL_&lt;asdl&gt;:OBJect** &lt;Distance&gt;,&lt;Attenuation&gt;

Defines the distance and attenuation (offset) for the analog stepped delay line.

The attenuation value depends on the following conditions:

- `ASDL_<asdl>:MANual` = MANual: command defines custom attenuation level.
- `ASDL_<asdl>:MANual` = OFFSet: command defines attenuation offset.

**Suffix:**

&lt;asdl&gt;        A | B

Analog stepped delay line (A = upper line, B = lower line)

**Parameters:**

&lt;Distance&gt;       Value multiplied by 10 defines the distance in cm, for example a value of 117 = 1170 cm.

Range:     0 to 129
*RST:      0

&lt;Attenuation&gt;   Range:     0 to 127
*RST:      0
Default unit: dB

**Example:**         //Configure analog stepped delay line A with attenuation offset

```
ASDL_A:OFFS
ASDL_A:OBJ 67,6
```

# 9 Troubleshooting

If you need to transport or ship the product, see Chapter 10, "Transporting", on page 54.

## 9.1 Contacting customer support

**Technical support – where and when you need it**

For quick, expert help with any Rohde & Schwarz product, contact our customer support center. A team of highly qualified engineers provides support and works with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz products.

**Contact information**

Contact our customer support center at www.rohde-schwarz.com/support, or follow this QR code:



*Figure 9-1: QR code to the Rohde & Schwarz support page*

# 10  Transporting

**Lifting and carrying**

See:

- "Lifting and carrying the product" on page 6

**Packing**

Use the original packaging material. It consists of antistatic wrap for electrostatic protection and packing material designed for the product.

If you do not have the original packaging, use similar materials that provide the same level of protection.

**Securing**

When moving the product in a vehicle or using transporting equipment, make sure that the product is properly secured. Only use items intended for securing objects.

**Transport altitude**

The maximum transport altitude without pressure compensation is 4500 m above sea level.

# 11 Maintenance, storage and disposal

The product does not require regular maintenance. It only requires occasional cleaning. It is however advisable to check the nominal data from time to time.

## 11.1 Changing fuses

If the product does not start, it is possible that a blown fuse is the cause. The fuse is located in the socket of the power supply.

The R&S QAT is protected by two time lag fuses (IEC 60127-2/5: T4.0H/250V, order number 0020.7600.00). The fuse holder is located next to the AC main switch and the AC power connector.

1. **WARNING!** The fuse is part of the main power supply. Handling the fuse while the power is on can lead to electric shock.

   Before changing the fuse:

   a) Set the switch on the power supply to position [0].
   b) Disconnect the product from the power source.

2. Bend the small clamps on top and bottom of the fuse holder to unlock it.
   Use two small screwdrivers, for example.
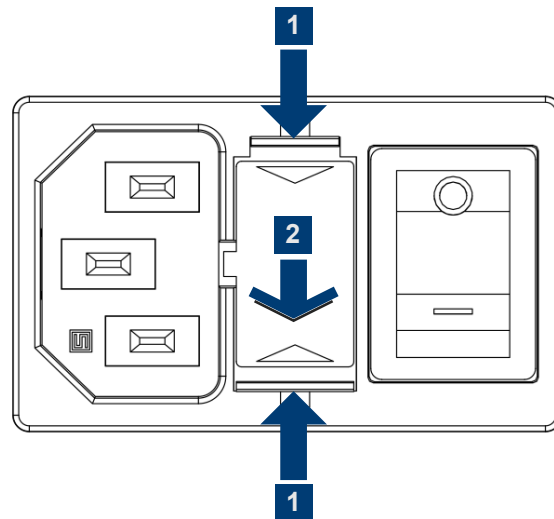


*Figure 11-1: Fuse replacement*

1 = Unlock fuse holder
2 = Remove fuse holder

3. Pull out the fuse holder.

4. Check the condition of the fuse.

5. Replace the blown fuse. Only use a fuse of the specified type.

The fuse type and its characteristics are indicated next to the fuse holder.

6. Insert the fuse holder into the mains power inlet.

## 11.2 Storage

Protect the product against dust. Ensure that the environmental conditions, e.g. temperature range and climatic load, meet the values specified in the data sheet.

## 11.3 Disposal

Rohde & Schwarz is committed to making careful, ecologically sound use of natural resources and minimizing the environmental footprint of our products. Help us by disposing of waste in a way that causes minimum environmental impact.

**Disposing electrical and electronic equipment**

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its service life. Even disposal via the municipal collection points for waste electrical and electronic equipment is not permitted.



*Figure 11-2: Labeling in line with EU directive WEEE*

Rohde & Schwarz has developed a disposal concept for the eco-friendly disposal or recycling of waste material. As a manufacturer, Rohde & Schwarz completely fulfills its obligation to take back and dispose of electrical and electronic waste. Contact your local service representative to dispose of the product.

# List of commands